Tier 3 engines rated at or above 37 kW that is conducted by the Administrator shall be performed using test fuels that meet the specifications in Table 4 in Appendix A of this subpart and that have a sulfur content no higher than 0.20 weight percent.

(c) Other fuels may be used for testing provided they meet the following qualifications:

(1) They are commercially available;

(2) Information acceptable to the Administrator is provided to show that only the designated fuel would be used in customer service;

(3) Use of a fuel listed under paragraph (b) of this section would have a detrimental effect on emissions or durability; and

(4) Fuel specifications are approved in writing by the Administrator prior to the start of testing.

(d) Report the specification range of the fuel to be used under paragraphs (b)(2) and (c)(1) through (c)(4) of this section in the application for certification in accordance with § 89.115 (a)(8).

(e) *Low-sulfur test fuel.* (1) Upon request, for engines rated at or above 75 kW in model years 2006 or 2007, the diesel test fuel may be the low-sulfur diesel test fuel specified in 40 CFR part 1065, subject to the provisions of this paragraph (e)(1).

(i) To use this option, the manufacturer must—

(A) Ensure that ultimate purchasers of equipment using these engines are informed that the use of fuel meeting the 500 ppm specification is recommended.

(B) Recommend to equipment manufacturers that a label be applied at the fuel inlet recommending 500 ppm fuel.

(ii) None of the engines in the engine family may employ sulfur-sensitive technologies.

(iii) For engines rated at or above 130 kW, this option may be used in 2006 and 2007. For engines rated at or above 75 kW and under 130 kW, this option may be used only in 2007.

(2) For model years 2008 through 2010, except as otherwise provided, the diesel test fuel shall be the low-sulfur diesel test fuel specified in 40 CFR part 1065.

(3) The diesel test fuel shall be the ultra low-sulfur diesel test fuel specified in 40 CFR part 1065 for model years 2011 and later.

(4) For model years 2007 through 2010 engines that use sulfur-sensitive emission-control technology, the diesel test fuel is the ultra low-sulfur fuel specified in 40 CFR part 1065 if the manufacturer demonstrates that the in-use engines will use only fuel with 15 ppm or less of sulfur.

(5) Instead of the test fuels described in paragraphs (e)(2) through (4) of this section, for model years 2008 and later, manufacturers may use the test fuel described in appendix A of this subpart. In such cases, the test fuel described in appendix A of this subpart shall be the test fuel for all manufacturer and EPA testing.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56995, 57013, Oct. 23, 1998; 69 FR 39213, June 29, 2004]

### § 89.331 Test conditions.

(a) *General requirements.* Calculate all volumes and volumetric flow rates at standard conditions for temperature and pressure (0 °C and 101.3 kPa), and these conditions must be used consistently throughout all calculations.

(b) *Engine test conditions.* Measure the absolute temperature (designated as $T$ and expressed in Kelvin) of the engine air at the inlet to the engine, and the dry atmospheric pressure (designated as $p$ and expressed in kPa), and determine the parameter $f$ according to the following provisions:

(1) Naturally aspirated and mechanically supercharged engines:

$$f = \frac{99}{p_s} \times \left( \frac{T}{298} \right)^{0.7}$$

(2) Turbocharged engine with or without cooling of inlet air:

$$f = \left( \frac{99}{p_s} \right)^{0.7} \times \left( \frac{T}{298} \right)^{1.5}$$

(c) For a test to be recognized as valid, the parameter $f$ shall be between the limits as shown below:

$$0.98 < f < 1.02$$

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56995, Oct. 23, 1998]

## APPENDIX A TO SUBPART D OF PART 89—TABLES

### TABLE 1—ABBREVIATIONS USED IN SUBPART D

| | |
|---|---|
| CLD | Chemiluminescent detector. |
| CO | Carbon monoxide. |
| $CO_2$ | Carbon dioxide. |
| HC | Hydrocarbons. |
| HCLD | Heated chemiluminescent detector. |
| HFID | Heated flame ionization detector. |
| GC | Gas chromatograph. |
| NDIR | Non-dispersive infra-red analyzer. |
| NIST | National Institute for Standards and Testing. |
| NO | Nitric Oxide. |
| $NO_2$ | Nitrogen Dioxide. |
| $NO_X$ | Oxides of nitrogen. |
| $O_2$ | Oxygen. |

### TABLE 2—SYMBOLS USED IN SUBPARTS D AND E

| Symbol | Term | Unit |
|---|---|---|
| conc | Concentration (ppm by volume) | ppm |
| f | Engine specific parameter considering atmospheric conditions | |
| $F_{FCB}$ | Fuel specific factor for the carbon balance calculation | |
| $F_{FD}$ | Fuel specific factor for exhaust flow calculation on dry basis | |
| $F_{FH}$ | Fuel specific factor representing the hydrogen to carbon ratio | |
| $F_{FW}$ | Fuel specific factor for exhaust flow calculation on wet basis | |
| FR | Rate of fuel consumed | g/h |
| $G_{AIRW}$ | Intake air mass flow rate on wet basis | kg/h |
| $G_{AIRD}$ | Intake air mass flow rate on dry basis | kg/h |
| $G_{EXHW}$ | Exhaust gas mass flow rate on wet basis | kg/h |
| $G_{Fuel}$ | Fuel mass flow rate | kg/h |
| H | Absolute humidity (water content related to dry air) | g/kg |
| i | Subscript denoting an individual mode | |
| $K_H$ | Humidity correction factor | |
| L | Percent torque related to maximum torque for the test mode | % |
| mass | Pollutant mass flow | g/h |
| $n_{d,i}$ | Engine speed (average at the i'th mode during the cycle) | 1/min |
| $P_s$ | Dry atmospheric pressure | kPa |
| $P_d$ | Test ambient saturation vapor pressure at ambient temperature | kPa |
| P | Observed brake power output uncorrected | kW |
| $P_{AUX}$ | Declared total power absorbed by auxiliaries fitted for the test | kW |
| $P_M$ | Maximum power measured at the test speed under test conditions | kW |
| $P_i$ | $P_i = P_{M,i} + P_{AUX,i}$ | |
| $P_B$ | Total barometric pressure (average of the pre-test and post-test values) | kPa |
| $P_v$ | Saturation pressure at dew point temperature | kPa |
| $R_a$ | Relative humidity of the ambient air | % |
| S | Dynamometer setting | kW |
| T | Absolute temperature at air inlet | K |
| $T_{bc}$ | Air temperature after the charge air cooler (if applicable) (average) | K |
| $T_{clout}$ | Coolant temperature outlet (average) | K |
| $T_{Dd}$ | Absolute dewpoint temperature | K |
| $T_{d,i}$ | Torque (average at the i'th mode during the cycle) | N-m |
| $T_{SC}$ | Temperature of the intercooled air | K |
| $T_{ref}$ | Reference temperature | K |
| $V_{EXHD}$ | Exhaust gas volume flow rate on dry basis | $m^3/h$ |
| $V_{AIRW}$ | Intake air volume flow rate on wet basis | $m^3/h$ |
| $P_B$ | Total barometric pressure | kPa |
| $V_{EXHW}$ | Exhaust gas volume flow rate on wet basis | $m^3/h$ |
| WF | Weighing factor | |
| $WF_E$ | Effective weighing factor | |

### TABLE 3—MEASUREMENT ACCURACY AND CALIBRATION FREQUENCY

| No. | Item | Calibration accuracy [1] | Calibration frequency |
|---|---|---|---|
| 1 | Engine speed | ±2% | 30 days. |
| 2 | Torque | Larger of ±2% of point or ±1% of engine maximum. | 30 days. |
| 3 | Fuel consumption (raw measurement) | ±2% of engine maximum | 30 days. |
| 4 | Air consumption (raw measurement) | ±2% of engine maximum | As required. |
| 5 | Coolant temperature | ±2°K | As required. |
| 6 | Lubricant temperature | ±2°K | As required. |
| 7 | Exhaust backpressure | ±1.0% of engine maximum | As required. |
| 8 | Inlet depression | 1.0% of engine maximum | As required. |
| 9 | Exhaust gas temperature | ±15°K | As required. |
| 10 | Air inlet temperature (combustion air) | ±2°K | As required. |
| 11 | Atmospheric pressure | ±0.5% | As required. |
| 12 | Humidity (combustion air) (g of $H_2O$/Kg of dry air) | ±0.5 | As required. |
| 13 | Fuel temperature | ±2°K | As required. |

TABLE 3—MEASUREMENT ACCURACY AND CALIBRATION FREQUENCY—Continued

| No. | Item | Calibration accuracy [1] | Calibration frequency |
|---|---|---|---|
| 14 | Temperature with regard to dilution tunnel | ±2°K | As required. |
| 15 | Dilution air humidity (g of $H_2O$/Kg of dry air) | ±0.5 | As required. |
| 16 | HC analyzer | ±2% | Monthly or as required. |
| 17 | CO analyzer | ±2% | Once per 60 days or as required. |
| 18 | $NO_X$ analyzer | ±2% | Monthly or as required. |
| 19 | Methane analyzer | ±2% | Monthly or as required. |
| 20 | $NO_X$ converter efficiency check | 90% | Monthly. |
| 21 | $CO_2$ analyzer | ±2% | Once per 60 days or as required. |

[1] All accuracy requirements pertain to the final recorded value which is inclusive of the data acquisition system.

TABLE 4—FEDERAL TEST FUEL SPECIFICATIONS

| Item | Procedure (ASTM) [1] | Value (type 2–D) |
|---|---|---|
| Cetane | D613–95 | 40–48 |
| Distillation Range: | | |
| IBP, °C | D86–97 | 171–204 |
| 10% point, °C | 86–97 | 204–238 |
| 50% point, °C | 86–97 | 243–282 |
| 90% point, °C | 86–97 | 293–332 |
| EP, °C | 86–97 | 321–366 |
| Gravity, API | D287–92 | 32–37 |
| Total Sulfur, %mass | D129–95 or D2622–98 | 0.03–0.40 |
| Hydrocarbon composition: | | |
| Aromatics, %vol | D1319–98 or D5186–96 | [2] 10 |
| Paraffins, Naphthenes, Olefins | D1319–98 | ([3]) |
| Flashpoint, °C (minimum) | D93–97 | 54 |
| Viscosity @ 38°C, Centistokes | D445–97 | 2.0–3.2 |

[1] All ASTM procedures in this table have been incorporated by reference. See § 89.6.
[2] Minimum.
[3] Remainder.

[63 FR 57013, Oct. 23, 1998]

APPENDIX B TO SUBPART D OF PART 89—FIGURES

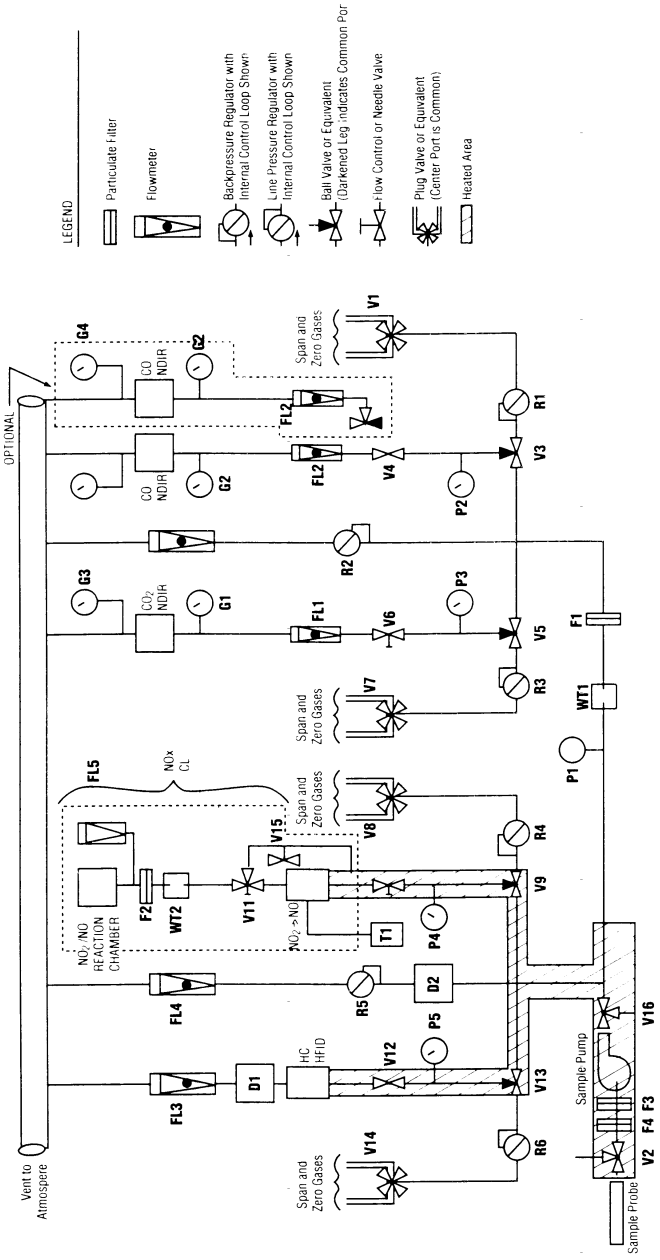


**Figure 1. — Exhaust Gas Sampling and Analytical Train**

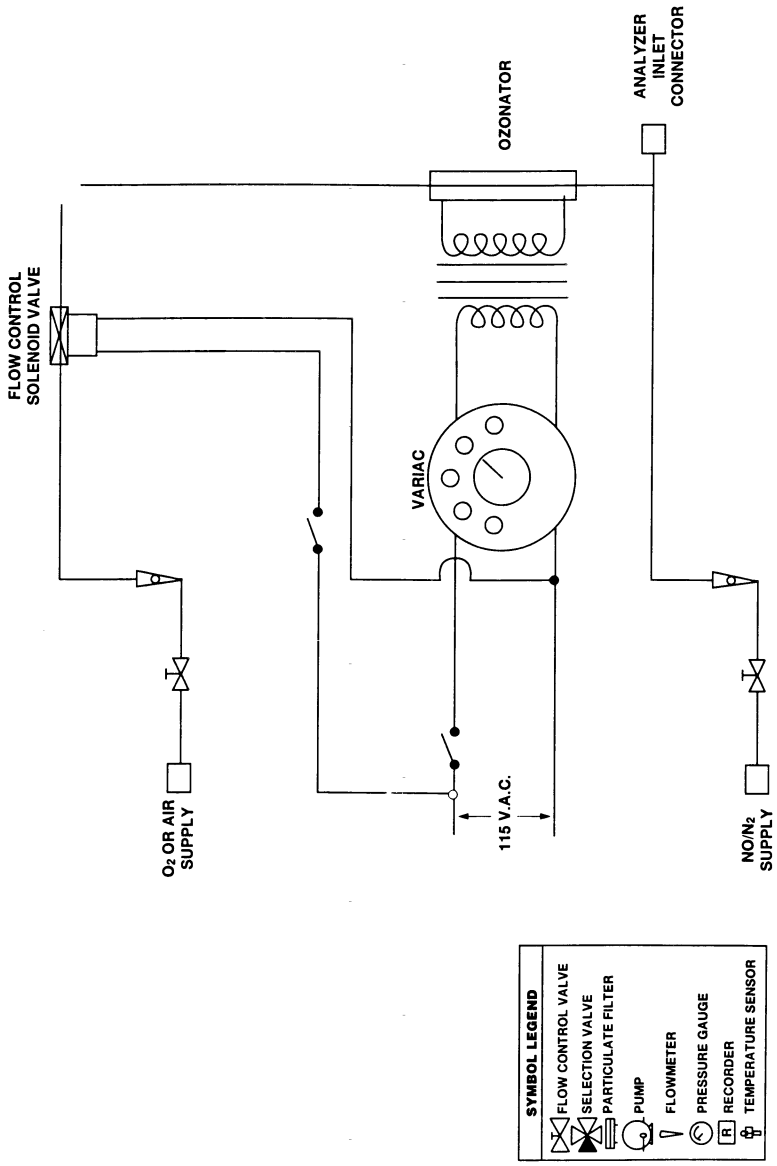


**Figure 2. — NOx Converter Efficiency Detector**

## Subpart E—Exhaust Emission Test Procedures

### § 89.401 Scope; applicability.

(a) This subpart describes the procedures to follow in order to perform exhaust emission tests on new nonroad compression-ignition engines subject to the provisions of subpart B of this part.

(b) Exhaust gases, either raw or dilute, are sampled while the test engine is operated using the appropriate test cycle on an engine dynamometer. The